

REMARKS

Applicants have amended claims 1, 2, 47, 50, 82, and 100. Applicants have added new claims 112-115.

Claims 2, 50, 82, and 100 stand rejected under 35 U.S.C. § 112, second paragraph, as allegedly being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Applicants have amended these claims in view of the Examiners rejection to delete the phrase "other ternary compounds." Accordingly, claims 2, 50, 82, and 100 are sufficiently definite. Applicants respectfully request that the 35 U.S.C. § 112, second paragraph, rejection of claims 2, 50, 82, and 100 be withdrawn.

Claims 1-111 stand rejected under 35 U.S.C. § 103 as allegedly being obvious in light of U.S. Patent No. 5,969,422 (Ting et al.). Applicants respectfully traverse this rejection.

As amended, claim 1 describes a method of plating a metal layer by "forming a barrier layer, containing a reducing agent," and "forming a metal seed layer . . . by reacting the barrier layer with a first plating solution." As claimed, this method provides for a barrier layer which comprises a reducing agent that will react with the first plating solution to form the metal seed layer. As a result, the reducing agent is present in a layer formed on the substrate to be plated.

Ting et al. does not disclose or suggest the formation of a metal seed layer by utilizing a substrate having a barrier layer "containing a reducing agent" which reacts with

a plating solution. Ting et al. teaches the depositing of an initial barrier layer, then depositing a catalytic seed layer on the barrier layer. Ting et al. utilizes an electroless solution comprising a reducing agent to deposit copper (*see* column 10, lines 51-52), but nowhere discloses, teaches, or suggests utilizing a barrier layer containing a reducing agent, which will react with a solution containing the metal to be deposited. The method of Ting et al. utilizes the barrier layer only to improve wetting of the seed layer (*see* column 7, line 27), or to prevent copper migration (*see* column 9, lines 55-56), and not to provide the reducing agent for the seed-layer-forming reaction. There is no teaching provided by Ting et al. which would motivate one of ordinary skill in the art to achieve the claimed process.

Because Ting et al. does not teach or suggest the utilization of a barrier layer, which contains a reducing agent so as to allow reaction with a solution, by which a metal seed layer is formed, claim 1, as amended, would not have been obvious in light of Ting et al. and is in form for immediate allowance. Because claims 2-25, and claim 112 depend from claim 1, none of these dependent claims would have been obvious in light of Ting et al. for at least the same reasons set forth above for claim 1. Additionally, each dependent claim, 2-25, is separately patentable because of its unique combination of steps constituting each claimed method, which is not shown or suggested by Ting et al., and which provides added reason for each dependent claim's individual allowance. Applicants respectfully request that the 35 U.S.C. § 103 rejection of claims 1-25 be withdrawn.

Claim 26 recites a method of fabricating a conductive layer on a semiconductor substrate by "forming a silicon layer on . . . the substrate," and "forming a metal seed layer

A

from the silicon layer by reacting the silicon layer with a first plating solution.” As claimed, this method provides for the forming of a metal seed layer from a silicon layer.

Ting et al. does not teach or suggest forming a silicon layer on a semiconductor substrate. Neither does Ting et al. teach thereafter reacting a silicon layer to form a metal seed layer. Though Ting et al. does teach the utilization of a barrier layer, it is not a silicon layer, and it is not reacted to become a metal seed layer.

Because Ting et al. does not teach forming a silicon layer over a semiconductor substrate and forming a metal seed layer from that silicon layer, claim 26 would not have been obvious in light of Ting et al. and is in form for immediate allowance. Additionally, because claims 27-46 depend from claim 26, none of these dependent claims would have been obvious in light of Ting et al. for at least the same reasons set forth above for claim 26. Additionally, each dependent claim, 27-46, is separately patentable because of its unique combination of steps constituting each claimed method, which is not shown or suggested by Ting et al., and which provides added reason for each dependent claim’s individual allowance. Applicants respectfully request that the 35 U.S.C. § 103 rejection of claims 26-46 be withdrawn.

As amended, claim 47 describes a method of forming a metal interconnect for a semiconductor circuit by “forming a barrier layer, containing a reducing agent,” and “forming a metal seed layer on the barrier layer by reacting the barrier layer with a first plating solution.” Similarly to methods already discussed, this method provides for a

A

barrier layer containing a reducing agent, which will react with the first plating solution to form the metal seed layer.

As already discussed, Ting et al. does not teach or suggest a barrier layer “containing a reducing agent” which reacts with a plating solution to form a metal seed layer. For reasons discussed above, there is no teaching provided by Ting et al. which would motivate one of ordinary skill in the art to achieve the claimed process.

Because Ting et al. does not teach or suggest the utilization of a barrier layer containing a reducing agent to form a metal seed layer, claim 47, as amended, would not have been obvious in light of Ting et al. and is in form for immediate allowance. Because claims 48-74, and 113 depend from claim 47, none of these dependent claims would have been obvious in light of Ting et al. for at least the same reasons set forth above for claim 47. Additionally, each dependent claim, 48-74, is separately patentable because of its unique combination of steps constituting each claimed method, which is not shown or suggested by Ting et al., and which provides added reason for each dependent claim’s individual allowance. Applicants respectfully request that the 35 U.S.C. § 103 rejection of claims 47-74 be withdrawn.

Claim 75 recites a method of forming a metal interconnect for a semiconductor circuit by “forming a silicon oxide layer” on a semiconductor substrate and its devices, and “reacting the silicon oxide layer with a first plating solution” to form a metal seed layer. As claimed, this method provides for the forming of a metal seed layer from a silicon oxide layer.

A

Ting et al. does not teach or suggest forming a silicon oxide layer over a semiconductor substrate and its devices. Neither does Ting et al. teach forming a metal seed layer from a silicon oxide layer by reacting such a silicon oxide layer with a plating solution. Though Ting et al. does teach the utilization of a barrier layer, it is not a silicon oxide layer, and it is not reacted to form a metal seed layer from that layer.

Because Ting et al. does not teach forming a silicon oxide layer over a semiconductor substrate and its devices and forming a metal seed layer from that silicon layer, claim 75 would not have been obvious in light of Ting et al. and is in form for immediate allowance. Additionally, because claims 76-95, and 114 depend from claim 75, none of these dependent claims would have been obvious in light of Ting et al. for at least the same reasons set forth above for claim 75. Additionally, each dependent claim, 76-95, is separately patentable because of its unique combination of steps constituting each claimed method, which is not shown or suggested by Ting et al., and which provides added reason for each dependent claim's individual allowance. Applicants respectfully request that the 35 U.S.C. § 103 rejection of claims 75-95 be withdrawn.

Claim 96 recites a method of plating copper onto a substrate by "forming a barrier layer," then "forming a silicon oxide layer on the barrier layer," and "forming a copper seed layer from the silicon oxide layer by reacting the silicon oxide layer with a plating solution." As claimed, this method provides an additional layer over a barrier layer. This additional layer is silicon oxide and reacts with a plating solution to become a copper seed layer.

A

Ting et al. does not teach or suggest utilizing a barrier layer and a silicon oxide layer over that barrier layer. Neither does Ting et al. suggest forming a copper seed layer from a silicon oxide layer by reacting such a silicon oxide layer with a plating solution.

Because Ting et al. does not teach utilizing a barrier layer, a silicon oxide layer, and reacting that silicon oxide layer to form a copper seed layer, claim 96 would not have been obvious in light of Ting et al. and is in form for immediate allowance. Because claims 97-110, and 115 depend from claim 96, none of these dependent claims would have been obvious in light of Ting et al. for at least the same reasons set forth above for claim 96. Additionally, each dependent claim, 97-110, is separately patentable because of its unique combination of steps constituting each claimed method, which is not shown or suggested by Ting et al., and which provides added reason for each dependent claim's individual allowance. Applicants respectfully request that the 35 U.S.C. § 103 rejection of claims 96-110 be withdrawn.

Claim 111 recites a method of forming a copper interconnect for a semiconductor circuit by "forming a barrier layer" approximately 50-500 Angstroms thick, "forming a silicon dioxide layer on the barrier layer," wherein the silicon dioxide layer is approximately 10-200 Angstroms thick, and "forming a copper seed layer from the silicon dioxide layer by reacting the silicon dioxide layer with a plating solution."

Ting et al. does not teach or suggest utilizing a barrier layer approximately 50-500 Angstroms thick, utilizing a silicon dioxide layer approximately 10-200 Angstroms thick, or reacting a silicon dioxide layer with a plating solution to form a copper seed layer.

Because Ting et al. does not teach forming the barrier layer, forming a silicon dioxide layer over the barrier layer, and reacting the silicon dioxide layer to form a copper seed layer, claim 111 would not have been obvious in light of Ting et al. and is in form for immediate allowance. Applicants respectfully request that the 35 U.S.C. § 103 rejection of claim 111 be withdrawn.

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to withdraw the outstanding rejection of the claims and to pass this application to issue.

Dated: May 15, 2000

Respectfully submitted,

By 

Thomas J. D'Amico

Registration No.: 28,371

DICKSTEIN SHAPIRO MORIN &

OSHINSKY LLP

2101 L Street NW

Washington, DC 20037-1526

(202) 785-9700

Attorneys for Applicants